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(Translation)

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Title of the Invention: SHEET-LIKE DISPLAY MEDIUM AND DISPLAY DEVICE
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[Claims]
[Claim 1] A sheet-like display medium, comprising:

an electrochromic layer having a predetermined display area on one surface thereof and exhibiting a transparent region and a colored region based on an electrochromic reaction;

an electrophoretic layer having the predetermined display area on one surface thereof and having a dispersion medium contained in a space therein and a plurality of electrophoretic particles dispersed in the dispersion medium; and

a transparent planar electrode interposed between another surface of the electrochromic layer, opposite to the one surface thereof, and the one surface of the electrophoretic layer.

[Claim 2] A sheet-like display medium according to claim 1, wherein the transparent planar electrode is converted between insulative and conductive by receiving a conversion energy.

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[Claim 3] A sheet-like display medium according to claim 2, wherein the transparent planar electrode is a photoconductive layer which is converted by receiving, as the conversion energy, optical radiation, excluding visible light, such as an ultraviolet ray or an infrared ray.

[Claim 4] A sheet-like display medium according to claim 1, wherein the electrochromic layer comprises, on the one surface thereof, an anisotropic conductive layer, the anisotropic conductive layer being conductive in a thickness direction and not conductive in a two-dimensional direction which is orthogonal to the thickness direction.

[Claim 5] A sheet-like display medium according to claim 1, wherein:

the electrophoretic layer is such that the dispersion medium and the electrophoretic particles have a first color and a second color; and

the electrochromic layer is such that the colored region has a third color.

[Claim 6] A sheet-like display medium according to claim 5, wherein: the electrophoretic layer and the electrochromic layer comprise a combination of red, green and blue as the first to third colors.

[Claim 7] A display device, comprising:

electrochromic display means for displaying a two-dimensional image with a transparent region and a colored region formed according to a predetermined two-dimensional current path pattern; and

electrophoretic display means laminated with the electrochromic display means for displaying a two-dimensional image with electrophoretic particles moving according to a predetermined two-dimensional electric field pattern so as to allow the image to be observed via the transparent region of the electrochromic display means.

[Claim 8] A display device according to claim 7, wherein the electrochromic display means and the electrophoretic display means display the two-dimensional image in color.

[Claim 9] A display device according to claim 7, wherein the electrochromic display means and the electrophoretic display means display the two-dimensional images to be superimposed on one another.

[Claim 10] A display device according to claim 7, wherein:

the electrochromic display means comprises: an electrochromic layer having a predetermined display area on one surface thereof and exhibiting the transparent region and the colored region based on an electrochromic reaction; a transparent current supply electrode provided on the one surface of the electrochromic layer for supplying to the electrochromic layer a current according to the predetermined two-dimensional current path pattern for exciting the electrochromic reaction; and a transparent planar electrode provided on another surface of the electrochromic layer, opposite to the one surface thereof, and serving as a counter electrode for the current supply electrode; and

the electrophoretic display means comprises: an electrophoretic layer having the predetermined display area on the first surface thereof and having a dispersion medium contained in a space therein and a plurality of electrophoretic particles dispersed in the dispersion medium; and an electric field application electrode for applying to the electrophoretic layer an electric field according to the predetermined two-dimensional electric field pattern.

[Claim 11] A display device according to claim 10, wherein:

the current supply electrode is a group of individual electrodes arranged in a matrix which are in contact with the one surface of the electrochromic layer and insulated from one another;

the transparent planar electrode is converted between insulative and conductive by receiving a conversion energy;

the electric field application electrode comprises the group of individual electrodes and an electric field planar electrode provided on another surface of the electrophoretic layer opposite to the one surface;

a current according to the predetermined two-dimensional current path pattern flows between the group of individual electrodes and the transparent planar electrode converted to be conductive; and

an electric field according to the two-dimensional electric field pattern is formed between the group of individual electrodes and the electric field planar electrode when the transparent planar electrode is converted to be insulative.

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[Claim 12] A display device according to claim 10, wherein: the electrochromic layer, the transparent planar electrode and the electrophoretic layer are in an integrated sheet-like form and removable from the current supply electrode and the electric field application electrode.

[Claim 13] A display device according to claim 10, wherein: the transparent planar electrode is a photoconductive layer which is converted by receiving, as the conversion energy, optical radiation, excluding visible light, such as an ultraviolet ray or an infrared ray.

[Claim 14] A display device according to claim 10, wherein:

the electrophoretic layer is such that the dispersion medium and the electrophoretic particles have a first color and a second color, respectively; and

the electrochromic layer is such that the colored region has a third color.

[Claim 15] A display device according to claim 14, wherein: the electrophoretic layer and the electrochromic layer comprise a combination of red, green and blue as the first to third colors.

[Detailed Description of the Invention]
[0001]
[Field of the Invention] The present invention relates to a sheet-like display medium and a display device using an electrochromic layer and an electrophoretic layer and, more particularly, to a sheet-like display medium

and a display device capable of multicolor display with a high paper-substituting property.

[0002]
[Prior Art] The development of data processing apparatuses in recent years has greatly improved the productivity of office work, while it also has greatly increased the consumption of paper. This is not desirable in view of the global environment protection. Developments have been taken against this, such as recycling of paper, use of non-wood paper, intensive development of a rewritable sheet-like display medium. While these developments have different objects for different applications, the rewritable sheet-like display medium, among others, has been expected to be valuable as a paper substitute or a new tool, because such a display medium does not require processes such as distribution/regeneration once it is manufactured and distributed to a user.

[0003] Conventionally, the following types have been known as such a sheet-like display medium or a display device.

(A) Those utilizing physical/chemical changes induced by heating/cooling processes so as to switch a material between an uncolored state and a colored (or cloudy) state (e.g., those utilizing a low/high molecular composite material, those utilizing coloring/discoloring of a leuco dye) ("Japan Hardcopy '95, Papers").

(B) Those in which colored particles are moved in a dispersion medium with an applied electric field (e.g.,

those utilizing electrophoresis) (e.g., Japanese Patent Laid-Open Publication No. 61-86780, Japanese Patent Laid-Open Publication No. 1-267525, Japanese Patent Laid-Open Publication No. 4-345133).

(C) Those in which a cholesteric liquid crystal material is selectively placed into a reflective/transmissive state with an applied electric field (e.g., Japanese Patent Laid-Open Publication No. 7-287214).

(D) Those in which a material is electrochemically colored (utilizing electrochromism) (e.g., Japanese Patent Laid-Open Publication No. 4-37895, "Color Optics Handbook").

[0004]
[Problems to be Solved by the Invention] However, the conventional sheet-like display media or display devices have the following problems. While those of type (A) can easily conduct a 2-color display by utilizing a thermal print head, they are not capable of a high-speed display because the operating principle thereof includes an effect of heating/cooling, and a high display contrast cannot easily be obtained, while it is difficult to conduct a color display. In those of type (B), images can be written only by controlling the applied electric field, so that a high-speed display can be conducted by a two-dimensional driving method, or the like, and the color variation is relatively wide. However, it is difficult to increase the number of colors to be displayed. In those of type (C), images can be written only by controlling the applied electric field, as in those of type (B), so that a high-speed display can be conducted by a

two-dimensional driving method, or the like, while a color display can also be realized. However, the optical reflection efficiency is poor, whereby only a dark display can be obtained. In order to solve this problem, the device would be complicated and the viewing angle dependency would increase. In those of type (D), a beautiful display color and a wide viewing angle can be advantageously obtained. However, it is difficult to increase the number of colors to be displayed. If a multicolor display is to be conducted, a good display property and a memory property can be obtained only for certain colors.

[0005] Thus, an object of the present invention is to provide a sheet-like display medium and a display device with a memory property, a high-speed response property, a high image quality, and a high paper-substituting property. A further object of the present invention is to provide a sheet-like display medium and a display device with a memory property, a high-speed response property, a color display accommodating property, a high image quality, and a high paper-substituting property.

[0006]
[Means for Solving the Problems] In order to achieve these objects, the present invention provides a sheet-like display medium, comprising: an electrochromic layer having a predetermined display area on one surface thereof and exhibiting a transparent region and a colored region based on an electrochromic reaction; an electrophoretic layer having the predetermined display area on one surface thereof and having a dispersion medium contained in a space therein and a plurality of

electrophoretic particles dispersed in the dispersion medium; and a transparent planar electrode interposed between another surface of the electrochromic layer opposite to the one surface thereof and the one surface of the electrophoretic layer. With such a structure, images can be displayed by the electrochromic layer and the electrophoretic layer, whereby it is possible to provide a memory property of retaining the display state after the power is turned off. Moreover, by employing a group of individual electrodes arranged in a matrix and a planar electrode as an electrode combination, it is possible to conduct matrix two-dimensional driving, whereby image data can be written to the sheet-like display medium at a high speed so as to provide a good high-speed response property. Furthermore, with the combination of the electrochromic layer and the electrophoretic layer, it is possible to conduct a clear display and thereby to obtain high-quality images. Thus, the paper-substituting property is increased by providing the memory property, the high-speed response property and the high image quality.

[0007] In order to obtain these objectives, the present invention also provides a display device, comprising: electrochromic display means for displaying a two-dimensional image with a transparent region and a colored region formed according to a predetermined two-dimensional current path pattern; and electrophoretic display means laminated with the electrochromic display means for displaying a two-dimensional image with electrophoretic particles moving according to a predetermined two-dimensional electric field pattern so as to allow the image to be observed via the transparent re-

gion of the electrochromic display means. With such a structure, images can be displayed by the electrochromic display means and the electrophoretic display means, whereby it is possible to provide a memory property of retaining the display state after the power is turned off. Moreover, by employing a group of individual electrodes arranged in a matrix and a planar electrode as an electrode combination, it is possible to conduct matrix two-dimensional driving, whereby image data can be written to the sheet-like display medium at a high speed so as to provide a good high-speed response property. Furthermore, with the combination of the electrochromic display means and the electrophoretic display means, it is possible to produce a clear display and thereby to obtain high-quality images. Thus, the paper-substituting property is increased by providing the memory property, the high-speed response property and the high image quality.

[0008]
[Embodiments of the Invention] A display device according to an embodiment of the present invention will now be described in detail with reference to the Figures. The display device includes a sheet-like display medium for conducting a multicolor display and a driver for driving the sheet-like display medium.

[0009] Figure 1 is a cross-sectional view illustrating a structure of the sheet-like display medium. The sheet-like display medium 1 comprises: an electrochromic layer (hereinafter, referred to as the "EC layer") 2 having a predetermined display area and exhibiting a transparent region and a colored region (e.g., a blue region) by an

electrochromic reaction based on a voltage/current control; an electrophoretic layer **3** having the same display area as that of the EC layer **2** and exhibiting a first colored region (e.g., a red region) and a second colored region (e.g., a green region) of colors different from that of the colored region of the EC layer **2** by controlling an applied electric field; and a transparent intermediate layer **4** interposed between the EC layer **2** and the electrophoretic layer **3**. A transparent anisotropic conductive layer **5** is formed on an observed side A of the EC layer **2**, and a supporting substrate **6** of a plastic, or the like, is provided on a non-observed side B of the electrophoretic layer **3**. The sheet-like display medium **1** is capable of displaying, on the observed side A, multiple colors including red, green, blue and mixed colors thereof.

[0010] The EC layer **2** is formed in a space kept by a spacer **7A** between the intermediate layer **4** and the anisotropic conductive layer **5**. For example, a WO_3-type electrochromic material consisting of three layers, which are sequentially formed on the observed side A, of an amorphous tungsten oxide (a-WO_3), tantalum pentoxide (Ta_2O_5) and an iridium oxide (IrO_x) may be used for the EC layer **2**. When a negative voltage is applied to the WO_3 side, an electron and an ion are injected into WO_3, and transparent WO_3 is reduced into a blue tungsten bronze (H_xWO_3) as a colored region, thereby coloring the WO_3-type electrochromic material in blue. The colored state is retained after the voltage is removed, and is erased only by applying an inverse voltage so as to oxidize the blue H_xWO_3 back to transparent.

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[0011] The electrophoretic layer **3** is formed in a space kept by a spacer **7B** between the intermediate layer **4** and the supporting substrate **6**, and has a plurality of electrophoretic particles **3b** dispersed in a dispersion medium **3a**. The dispersion medium **3a** may be an insulative organic solvent, such as an isoparaffin-type hydrocarbon, hexylbenzene, tetrafluorodibromoethane, perfluoropolyether or toluenetrifluoride, mixed with a red dye and an ionic surfactant for controlling an electric charge on the surface of the electrophoretic particles **3b**. The polarity of the electrophoretic particles **3b** is determined by the ionic surfactant. Herein, the surface of the electrophoretic particles **3b** are negatively charged. The electrophoretic particles **3b** may be particles obtained by dispersing a green pigment in a polyethylene wax. When an electric field is applied to the electrophoretic layer **3**, the negatively charged electrophoretic particles **3b** move toward the side to which a positive voltage is applied, thereby displaying the red of the dispersion medium **3a** or the green of the electrophoretic particle **3b**. The display state is retained after the voltage is removed, and is erased only by applying an inverse voltage.

[0012] The intermediate layer **4** is obtained by coating a transparent ultraviolet conductive layer **4b** such as tin oxide which changes from insulative to conductive using ultraviolet radiation, over the entire surface of a transparent polyethylene film **4a** on the observed side A. An end portion **4c** of the intermediate layer **4**, including the film **4a** and the conductive layer **4b**, is slightly exposed from the EC layer **2** and the electrophoretic layer **3** for electrical connection to a driver **10**

which will be described later. The ultraviolet conductive layer **4b** may be another member which is converted between insulative and conductive by receiving a conversion energy, e.g., a photoconductive layer which is converted from insulative to conductive by optical radiation, excluding visible light, such as an infrared ray. The EC layer **2** and the electrophoretic layer **3** can be sequentially driven basically with a pair of electrodes by appropriately converting between insulative and conductive based on the presence/absence of optical radiation.

[0013] Figure **2** is a plan view illustrating the anisotropic conductive layer **5**. The anisotropic conductive layer **5** is obtained by dispersing a plurality of conductive particles **5b** in a film **5a**. The portion of the anisotropic conductive layer **5** where the conductive particles **5b** exist has a conduction anisotropy wherein the portion is conductive in the thickness direction thereof due to a conduction effect and is not conductive in a two-dimensional direction which is orthogonal to the thickness direction. As the anisotropic conductive layer **5** is provided on the observed side A, the film may be a transparent plastic, and the conductive particle **5b** may be obtained by coating a transparent conductive film, such as a transparent conductive layer of indium tin oxide, or the like, on the surface of a transparent particle of glass, plastic, or the like. In such a case, it is preferable for preventing images from being skewed that the transparent film **5a** and the transparent conductive particles **5b** have substantially the same refractive index.

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[0014] Figure 3 is a cross-sectional view illustrating a structure of the driver. The driver **10** has a case **11** of a transparent plastic, or the like. The case **11** has an attachment cavity **11a** for attachment of the sheet-like display medium **1**, and an abutting portion **11b** for positioning the sheet-like display medium **1**. The attachment cavity **11a** includes a group of individual electrodes **12**, which are transparent and are arranged in a matrix, and a planar electrode **13** provided on the inner surface thereof so as to oppose each other. The attachment cavity **11a** includes an insertion hole **11c** provided on the bottom side thereof into which the end portion **4c** of the intermediate layer **4** is inserted. The insertion hole **11c** includes a connection terminal **14** which can be connected to the ultraviolet conductive layer **4b** of the intermediate layer **4**. The driver **10** includes a driving circuit **15** for driving the sheet-like display medium **1**, a switch **16** for controlling the connection potential for the planar electrode **13**, and an ultraviolet irradiation apparatus **17** for irradiating the ultraviolet conductive layer **4b** with an ultraviolet ray. A driving line **18a** connected to the group of individual electrodes **12** and a grounded earth line **18b** are provided to extend from the driving circuit **15**. The earth line **18b** is connected to the connection terminal **14** and the planar electrode **13** via the switch **16**, respectively.

[0015] The group of individual electrodes **12** includes a plurality of individual electrodes **12b** made of a transparent conductive film of iridium tin oxide (ITO), or the like, which are arranged in a matrix via a transparent insulative region **12a**. The group of individual elec-

trodes **12** is driven by a thin film transistor using a polysilicon.

[0016] The driving circuit **15** acts on the sheet-like display medium **1** in synchronism with the ultraviolet irradiation apparatus **17**. When the ultraviolet irradiation apparatus **17** is ON, a DC voltage according to an input image signal S is applied to the group of individual electrodes **12** so as to supply a current to the EC layer **2**, thereby displaying transparent and blue. When the ultraviolet irradiation apparatus **17** is OFF, a DC voltage according to the input image signal S is applied to the group of individual electrodes **12** so as to apply an electric field through the electrophoretic layer **3**, thereby displaying red and green.

[0017] Next, an operation of the present display device will be described.

(1) Attachment of Sheet-Like Display Medium **1** to Driver **10**

Figure **4** is a cross-sectional view illustrating a display state of the display device. An operator attaches a new sheet-like display medium **1**, or a sheet-like display medium **1** which needs to be rewritten, as illustrated in Figure **1**, to the driver **10**, as illustrated in Figure **4**. In particular, the sheet-like display medium **1** is attached into the attachment cavity **11a**, with the anisotropic conductive layer **5** of the sheet-like display medium **1** facing the group of individual electrodes **12**, until the sheet-like display medium **1** abuts the abutting portion **11b**. The anisotropic conductive layer **5** contacts the group of individual elec-

trodes **12**, and the supporting substrate **6** contacts the planar electrode **13**. As the anisotropic conductive layer **5** contacts the group of individual electrodes **12**, the anisotropic conductive layer **5** and the group of individual electrodes **12** are put into a conductive state by the conduction anisotropy of the anisotropic conductive layer **5**.

[0018] (2) Writing Image Data to Electrophoretic Layer 3

First, the switch **16** is closed, and the ultraviolet irradiation apparatus **17** is turned OFF, so that the ultraviolet conductive layer **4b** is put into an insulative state. When the image signal S is externally input, the driving circuit **15** applies to the group of individual electrodes **12** an electrophoretic-layer-writing-voltage of the positive or negative polarity, e.g., +50 V, -50 V, according to the image signal S. The electrophoretic layer **3** is supplied with a voltage according to a partial voltage of the electrophoretic layer **3**, the intermediate layer **4** and the EC layer **2**. As shown in Figure **4**, since the surface of the electrophoretic particle **3b** is negatively charged, the electrophoretic particles **3b** located between the individual electrodes **12b**, to which a positive voltage is applied, and the planar electrode **13** migrate in the dispersion medium **3a** to gather on the side of the individual electrodes **12b**. The electrophoretic particles **3b** located between the individual electrodes **12b**, to which a negative voltage is applied, and the planar electrode **13** migrate in the dispersion medium **3a** to gather on the side of the planar electrode **13**. From the observed side A, the green electrophoretic particles **3b** are seen in areas where the electrophoretic particles **3b** have gathered due to the

applied positive voltage, thereby presenting a green display state. On the other hand, the red dispersion medium **3a** is seen in areas where the electrophoretic particles **3b** have gone away due to the applied negative voltage, thereby presenting a red display state.

[0019] (3) Writing Image Data to EC Layer **2**

When the write operation to the electrophoretic layer **3** is completed, the switch **16** is opened, and the ultraviolet irradiation apparatus **17** is turned ON, so that the ultraviolet conductive layer **4b** becomes conductive. When the image signal S is externally input, the driving circuit **15** applies to the group of individual electrodes **12** an EC-layer-writing-voltage of the positive or negative polarity, e.g., +3 V, -3 V, according to the image signal S. By the action of the anisotropic conductive layer **5**, the applied voltage is transferred directly to the EC layer **2**. Thus, a circuit is formed in which a current flows from the group of individual electrodes **12**, through the EC layer **2**, to the ultraviolet conductive layer **4b**. Areas of the EC layer **2** become transparent where the positive voltage is applied to the individual electrodes 12b, and other areas of the EC layer **2**, where the negative voltage is applied to the individual electrodes **12b**, are colored in blue as blue tungsten bronze (H_xWO_3) **2a** is formed on the observed side A. When the write operation to the EC layer **2** is completed, the ultraviolet irradiation apparatus **17** is turned OFF. During this operation, the electrophoretic layer **3** for which the write operation has previously been completed is isolated from a circuit, but keeps displaying the still image for a long period of time without a power due to its memory property. By these op-

erations, image data consisting of red, green, blue and mixed colors thereof is written to the sheet-like display medium **1**. Thus, on the observed side A, the red or green of the electrophoretic layer **3** is seen in areas where the EC layer **2** is transparent, while blue is seen regardless of the color of the electrophoretic layer **3** in areas where the EC layer **2** is blue. Since the display state is retained after the voltage is removed, the sheet-like display medium **1** can retain the display after the sheet-like display medium **1** is removed from the driver **10**, as illustrated in Figure 5.

[0020] (4) Erasing Image Data

An inverse voltage of the EC-layer-writing-voltage written to the group of individual electrodes **12** is applied, while the sheet-like display medium **1** to which the image data has been written is being attached to the driver **10**. The blue tungsten bronze (H_xWO_3) **2a** of the EC layer **2** is oxidized back to transparent WO_3, thereby erasing the image data written to the EC layer **2**. Then, the switch **16** is closed, and an inverse voltage of the electrophoretic-layer-writing-voltage written to the group of individual electrodes **12** is applied. The electrophoretic particles **3b** of the electrophoretic layer **3** go back to the dispersed state, thereby erasing the image data written to the electrophoretic layer **3**.

[0021] The above-described display device provide the following effects. By employing the planar electrode **13** and the group of individual electrodes **12** arranged in a matrix as an electrode combination, it is possible to conduct matrix two-dimensional driving, whereby image can be written to the sheet-like display

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medium 1 at a high speed only by an electrical control. Therefore, a good high-speed response property can be provided. Moreover, with the combination of the electrophoretic layer 3 for displaying the first color (red) and the second color (green) and the EC layer 2 for displaying transparent and the third color (blue), a 3-color display can be performed. Furthermore, half tone mixed colors can easily be displayed by changing the display area proportion among the respective colors. Thus, a good color display accommodating property can be provided. Moreover, with the combination of the EC layer 2 and the electrophoretic layer 3, it is possible to conduct a clear multicolor display and thereby to obtain high-quality images. Furthermore, since images are displayed by the EC layer 2 and the electrophoretic layer 3, there is provided a memory property of retaining the display state after the power is turned off, and the sheet-like display medium 1 can be used repeatedly. As a result, it is possible to reduce the power consumption for displaying images. Moreover, by employing the anisotropic conductive layer 5, an applied voltage can be transferred directly to the EC layer 2 or the electrophoretic layer 3, thereby producing a high resolution image with a minimum applied voltage and thus reducing the power consumption. Furthermore, since the sheet-like display medium 1 has the memory property, the high-speed response property, the color display accommodating property, the high image quality and the low power consumption property, the paper-substituting property is increased, thereby contributing to global environment protection. Moreover, since the displayed images can be viewed from the observed side A while the sheet-like display medium 1 is attached to the driver 10, the in-

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ventive arrangement can be used as a display. Furthermore, since the sheet-like display medium 1 is not provided with a group of electrodes in a matrix or linear arrangement, the sheet-like display medium 1 can be produced using a simple and inexpensive structure, thereby reducing the cost for producing a plurality of still images. Moreover, since the dispersion medium 3a and the electrophoretic particles 3b of the electrophoretic layer 3 are colored with a dye or a pigment, the color variation is wide, and it is possible to easily select any two desired colors.

[0022] The present invention is not limited to the above-described embodiments, as various other embodiments may be possible. For example, when the inventive arrangement does not have to be used as a display, the case 11 and the group of individual electrodes 12 may be made of an opaque material. Moreover, the case 11 may be of a type which can be flipped open like a book or a binder.

[0023]
[Effects of the Invention] As described above, according to the present invention, images are displayed by the electrochromic layer and the electrophoretic layer, thereby providing a memory property of retaining the display state after the power is turned off. Moreover, by employing the group of individual electrodes arranged in a matrix and the planar electrode as an electrode combination, it is possible to conduct matrix two-dimensional driving, so that an image can be written to the sheet-like display medium at a high speed, thereby providing a good high-speed response property. Further-

more, with the combination of the electrochromic layer and the electrophoretic layer, it is possible to conduct a clear display and thereby obtain high-quality images. Therefore, by providing the memory property, the high-speed response property and the high image quality, the paper-substituting property is increased, thereby contributing to global environment protection. Moreover, with the combination of the electrophoretic layer for displaying the first color and the second color and the electrochromic layer for displaying a transparent state and the third color, a 3-color display can be performed. Furthermore, half tone mixed colors can easily be displayed by changing the display area proportion among the respective colors. Therefore, a good color display accommodating property can be provided. Thus, by providing the memory property, the high-speed response property, the color display accommodating property and the high image quality, the paper-substituting property is increased, thereby contributing to global environment protection.

[Brief Description of the Drawings]
[Figure 1] A cross-sectional view illustrating a structure of a sheet-like display medium according to the present invention.

[Figure 2] A front view of an anisotropic conductive layer according to the present invention.

[Figure 3] A cross-sectional view illustrating a structure of a driver according to the present invention.

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[Figure 4] A cross-sectional view illustrating a display state of a display device according to the present invention.

[Figure 5] A cross-sectional view illustrating a display state of the sheet-like display medium according to the present invention.

[Description of the Reference Numerals]
1 Sheet-like display medium
2 Electrochromic layer (EC layer)
2a Tungsten bronze (H_xWO_3)
3 Electrophoretic layer
3a Dispersion medium
3b Electrophoretic particle
4 Intermediate layer
4a Polyethylene film
4b Ultraviolet conductive layer
4c End portion
5 Anisotropic conductive layer
5a Film
5b Conductive particle
6 Supporting substrate
7A, 7B Spacer
10 Driver
11 Case
11a Attachment cavity
11b Abutting portion
11c Insertion hole
12 Group of individual electrodes
12a Insulative region
12b Individual electrode
13 Planar electrode

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14 Connection terminal
15 Driving circuit
16 Switch
17 Ultraviolet irradiation apparatus
18a Driving line
18b Earth line
A Observed side
B Non-observed side
S Image signal

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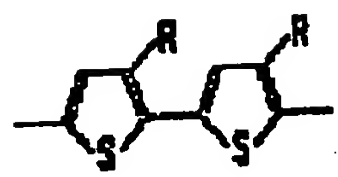
[Abstract]

[Problems] To provide a color display medium and a color display device with a memory property, a high-speed response property, a color display accommodating property, a high image quality, and a high paper-substituting property.

[Means for Solving the Problems] A driving circuit **15** applies to a group of individual electrodes **12** an electrophoretic-layer-writing-voltage of a positive or negative polarity according to an image signal S. A negatively charged electrophoretic layer **4** moves to the side to which a positive voltage is applied, thereby displaying a red of a dispersion medium **4a** or a green of electrophoretic particle **4b**. The driving circuit **15** applies to the group of individual electrodes **12** an EC-layer-writing-voltage of a positive or negative polarity according to the image signal S. Areas of an EC layer **2** applied with a positive voltage become transparent, and other areas of the EC layer **2** applied with a negative voltage are colored in blue. Image data consisting of red, green and blue is written to a color display medium **1**.



JP10190001
MANUFACTURE OF ORGANIC THIN FILM TRANSISTOR

LUCENT TECHNOL INC
Inventor(s): ;BAO ZHENAN ;DODABALAPUR ANANTH ;FENG YI ;RAJU VENKATARAM REDDY

Application No. 09331398 , **Filed** 19971202 , **Published** 19980721 ,

Abstract: PROBLEM TO BE SOLVED: To form an organic semiconductor layer by forming an active layer of organic material and permitting the layer to have a carrier mobility of a specific value or higher and a conductivity of a specific value or lower.

SOLUTION: An active semiconductor layer is formed of organic polymer having a carrier mobility of approximately 10^{-3}cm ^{2}/Vs or higher and a conductivity of approximately 10^{-5}s/cm or lower. An organic material active layer is composed of regioregular homopolymer (3-alkylthiophene). The alkyl group has at least 2-12 carbon atoms and is represented by a character R. Branched chains, such as isopropyl and isobutyl, and straight chain alkyl are the examples of the alkyl group. In the regioregular homopolymer of the 3-alkylthiophene monomer, the orientation of the alkl group of the thiophene part is regular in regard to the thiophene part which adjoins the polymer chain.

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